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MULTIFUNCTIONAL SKYSCRAPERS: TYPES, FUNCTIONAL STRUCTURE AND MODERN TRENDS

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Abstract. This article analyzes the formation, types, functional structure, and development trends of multifunctional skyscrapers in contemporary urban planning and architecture. The architectural and practical characteristics of the concepts of the "vertical city," "closed urban block," and functionally transformable building are examined. The article also considers current trends such as green skyscrapers, smart buildings, hybrid structural systems, modular construction, and the integration of social infrastructure.

Keywords: multifunctional skyscraper, architecture, urban planning, vertical city, functional structure, functional zoning, vertical transportation, smart building, green skyscraper, IoT, energy efficiency, modular construction, hybrid structure, social infrastructure.

Introduction. The acceleration of urbanization processes, the limited availability of land resources in cities, and the growing demand for population and service facilities are making multifunctional skyscrapers one of the important directions of contemporary architecture. Such buildings differ from conventional multi-story structures not only in terms of their height but also in their ability to integrate various functional processes within a unified architectural, compositional, and structural system. The vertical or horizontal integration of residential, office, commercial, hotel, service, recreational, public, and other functions makes it possible to use urban space more efficiently.

The development of multifunctional skyscrapers has been closely associated with changes in economic, technological, and social processes in major cities since the second half of the twentieth century. Initially, high-rise buildings were primarily developed as administrative and business centers, but they subsequently evolved into complex urban complexes incorporating a variety of functions. At the present stage, functional flexibility, energy efficiency, environmental sustainability, digital management, "smart building" technologies, and the creation of a comfortable urban environment for people have become key factors in their architectural design.

The functional structure of multifunctional skyscrapers is formed depending on their role in urban planning, purpose of use, structural system, and the characteristics of user flows. In this context, the vertical division of functions into zones, the integration of public spaces with private areas, the organization of transport and pedestrian flows, the integration of engineering and communication systems, and the provision of safety requirements are important design considerations. In particular, placing several independent functions within a single building requires clear planning principles to ensure their compatibility and convenience of use.

Today, new trends are emerging in the architecture of multifunctional skyscrapers. In particular, climate-responsive façades, the use of solar energy, green roofs and vertical landscaping, natural ventilation, automated energy management, artificial intelligence, and IoT technologies are increasing not only the technical efficiency of buildings but also their environmental and social performance. At the same time, the impact of skyscrapers on the urban skyline, their compatibility with the historic environment, and their integration into the system of public spaces are also among the important challenges facing contemporary architecture.

Main Part. The concept of multifunctional skyscrapers emerged during the second half of the twentieth century. The idea was initially proposed by the American architect Ludwig Mies van der

Rohe, who introduced the concept of "universal space." According to his approach, a building should have an open-plan layout without permanent internal walls and should be sufficiently flexible to accommodate different functions [1]. Subsequently, during the 1960s and 1970s, multifunctional complexes began to be constructed in Europe within the framework of the "closed city" (ville fermée) concept. The La Défense complex in France and the Barbican Estate in London are considered among the earliest major projects representing this approach. La Défense developed as a modern business district, while the Barbican Estate in the United Kingdom became a multifunctional urban complex combining residential and cultural functions. These projects had a significant influence on the formation of contemporary multifunctional skyscraper complexes by implementing principles of vertical and horizontal functional integration, separation of transportation systems, and development of public spaces.

Since the 1980s, multifunctional skyscrapers have become increasingly widespread worldwide. This development was driven by several factors, including:

- increasing costs of urban land;
- changes in people's lifestyles;
- growing transportation problems;
- the need to conserve energy resources.

The Rockefeller Center in New York and Water Tower Place in Chicago are considered among the early successful examples of multifunctional high-rise complexes in the United States [2]. Today, buildings such as Burj Khalifa in Dubai, Shanghai Tower in Shanghai, and Petronas Towers in Kuala Lumpur represent some of the most prominent examples of this architectural trend.

The scientific classification of multifunctional skyscrapers is of considerable importance. Such a classification can be carried out according to several criteria. According to the Council on Tall Buildings and Urban Habitat (CTBUH), tall buildings can be categorized according to height as follows:

- tall buildings (50–100 meters);
- skyscrapers (100–300 meters);
- supertall buildings (above 300 meters) [3].

According to their functional composition, they can be divided into the following types:

- two-function buildings (residential and office);
- three-function buildings (residential, office, and commercial);
- multifunctional buildings (four or more functions).

According to their spatial planning structure, multifunctional skyscrapers can be classified into **horizontal, vertical, and mixed types**. Horizontal-type complexes consist of several buildings interconnected by pedestrian walkways, galleries, and covered passages. In vertical-type buildings, different functions are arranged vertically within a single building. Mixed-type complexes combine elements of both approaches [4]. According to their location, complexes can also be distinguished as those situated in the city center, within the central urban area, or on the outskirts of the city.

The main types of multifunctional skyscrapers can be considered separately. **The first type is the "Vertical City" concept.** In this type of building, different functions are arranged vertically. Commercial and service facilities are generally located on the lower floors, offices on the middle floors, and residential units and hotels on the upper floors. In his studies, A. Wood emphasizes that the "vertical city" concept is particularly effective in large metropolitan areas where land resources are limited [4]. Examples include Burj Khalifa in Dubai (828 meters, 163 floors) and Shanghai Tower in Shanghai (632 meters, 128 floors). Burj Khalifa incorporates a hotel, residential units, offices, retail facilities, and observation decks, functioning as a genuine "vertical city."

The second type is the "Closed Urban Block" concept. Complexes of this type consist of several buildings interconnected by pedestrian walkways, galleries, and covered passages. Open spaces between the buildings serve recreational and leisure purposes. Marina Bay Sands in Singapore and Roppongi Hills in Tokyo are examples of this type [5]. The Marina Bay Sands complex consists of three high-rise towers connected at the top by a large elevated public space known as the SkyPark. The complex includes a hotel, shopping center, museum, theater, casino, and various entertainment facilities.

The third type is the "Functionally Transformable Building" concept. Buildings of this type have the potential to change their function over time. For example, industrial buildings can be converted into lofts, while office buildings can be transformed into hotels. This concept is particularly important for the preservation of historic buildings and their adaptation to contemporary uses [6]. The High Line project in New York and the redevelopment of Battersea Power Station in London are successful examples of this approach.

The analysis of the functional structure of multifunctional skyscrapers is an important scientific task. Functional structure refers to the spatial arrangement of different functional zones within a building, the relationships between them, and their distribution in both vertical and horizontal directions. In contemporary multifunctional skyscrapers, several principles are followed when arranging functional zones.

The first principle is the "Zoning" principle. Under this approach, different functions are spatially separated from one another. For example, noisy and highly populated commercial and entertainment zones are generally located on the lower floors, while residential zones requiring privacy and a quiet environment are placed on the upper floors. This principle makes it possible to satisfy the specific requirements of each functional zone.

The second principle is the "Vertical Transportation" principle. Vertical transportation systems are particularly important in multifunctional skyscrapers. Elevators serving different functional zones should be separated from one another. For example, separate elevators may be provided for office employees, hotel guests, and residential occupants. This approach makes it possible to optimize pedestrian flows and reduce waiting times.

The third principle is the "Horizontal Connections" principle. Horizontal connections between different functional zones should be ensured. For this purpose, passageways, galleries, and atriums can be incorporated at different levels of the building. These elements facilitate convenient movement between functional zones and contribute to the spatial integrity of the building [7].

The fourth principle is the "Technical Zones" principle. In multifunctional skyscrapers, technical zones, including engineering systems, ventilation rooms, and transformer rooms, should be spatially separated. They are generally located in the lower, middle, and upper sections of the building [7].

Modern trends in the design of multifunctional skyscrapers should also be emphasized. **The first trend is the "Green Skyscraper" concept.** Within this concept, buildings are designed to meet requirements for energy efficiency and environmental sustainability. Green roofs, solar panels, wind turbines, and rainwater harvesting systems are becoming integral components of contemporary skyscrapers [6]. The Bosco Verticale (Vertical Forest) buildings in Milan are among the most well-known examples of this approach. More than 900 trees and over 2,000 plants are incorporated into the façades of the buildings, contributing to air purification and noise reduction.

The second trend is the "Smart Skyscraper" concept. Within this concept, buildings are equipped with artificial intelligence, IoT sensors, and automated management systems. The building manages its various systems in real time, optimizes energy consumption, and adapts to users' needs [8]. Shanghai Tower in Shanghai is a prominent example of a smart skyscraper. The building is equipped

with a double-skin façade system, a rainwater collection system, and 270 wind turbines, enabling it to reduce energy consumption by approximately 20 percent.

The third trend is the "Hybrid Structural Systems" concept. Contemporary skyscrapers increasingly combine different structural systems. Concrete and steel structures, external façade trusses, and internal core walls can be used together. This approach increases structural strength while reducing material consumption [8].

The fourth trend is the "Modular Construction" concept. Within this approach, building components are manufactured under factory conditions and subsequently assembled at the construction site. This makes it possible to reduce construction time, improve quality, and minimize construction waste [9].

The fifth trend is the "Social Infrastructure" concept. Contemporary multifunctional skyscrapers incorporate not only commercial and residential functions but also social infrastructure facilities, including kindergartens, schools, sports halls, medical facilities, and libraries. This enables residents to meet many of their daily needs within the complex and reduces their dependence on external transportation systems [10].

Multifunctional skyscrapers have both advantages and disadvantages. Their main advantages include efficient use of land resources, reduction of transportation loads, optimization of energy consumption, development of social interaction, increased economic efficiency, and enrichment of the urban skyline [11]. Their disadvantages include complex design and construction processes, high construction costs, management complexity, potential conflicts between different functions, difficulties associated with evacuation, and high operating costs [12].

In contemporary urban planning, multifunctional skyscrapers are considered one of the important means of efficiently utilizing urban land, integrating different functions within a unified architectural and planning system, and adapting to urbanization processes. The integration of residential, office, commercial, hotel, entertainment, and social service functions within such buildings increases the functional density of urban space while enabling residents to meet their everyday needs within a single area.

As multifunctional skyscrapers have evolved, their architectural and planning solutions have improved significantly. The use of vertical, horizontal, and mixed planning systems makes it possible to arrange different functions efficiently, regulate pedestrian flows, and maintain a balance between public and private spaces. From this perspective, functional zoning, the proper organization of vertical transportation, the formation of horizontal connections, and the rational placement of technical zones emerge as the key principles ensuring the effective operation of multifunctional skyscrapers.

Analysis of the research materials demonstrates that environmental sustainability and technological integration have become particularly important at the contemporary stage of multifunctional skyscraper development. The implementation of green roofs, vertical landscaping, solar energy systems, rainwater harvesting, and energy-efficient engineering systems contributes to improving the environmental performance of buildings. At the same time, the use of IoT, artificial intelligence, and automated management systems expands opportunities for optimizing building operations and adapting them to users' needs.

The integration of structural and technological solutions is also an important factor in the design of multifunctional skyscrapers. The use of hybrid structural systems, modular construction technologies, and modern façade solutions can improve the structural strength, energy efficiency, and operational performance of buildings. However, the complex functional composition of such developments also makes the processes of design, construction, and management more complicated. In particular, the separation of flows between different functions, ensuring safe evacuation, managing engineering systems, and reducing high operating costs require particular attention.

Conclusion. The integration of functional, urban-planning, environmental, structural, and technological factors is one of the fundamental conditions for the formation of multifunctional skyscrapers. Their future development will be determined not merely by increasing building height, but by creating a comfortable, safe, energy-efficient, environmentally sustainable, and intelligent urban environment for people. This approach demonstrates the necessity of integrating local climatic conditions, urban-planning structure, historical and cultural context, and contemporary technologies when developing multifunctional skyscrapers and complexes in Uzbekistan, particularly in the city of Samarkand.

Literature

1. Mis van der Rohe L. Mis van der Rohe: The Artless Word: Mies van der Rohe on the Building Art. – Cambridge: MIT Press, 1991.
2. Koolhaas R. Delirious New York: A Retroactive Manifesto for Manhattan. – New York: The Monacelli Press, 1994.
3. Council on Tall Buildings and Urban Habitat (CTBUH). Tall Building Criteria: Height and Use Classification. – Chicago: CTBUH.
4. Wood A. The Tall Buildings Reference Book. – London: Routledge, 2013.
5. Yudelson J. The Green Building Revolution. – Washington: Island Press, 2008. – 256 p.
6. Batty M. The New Science of Cities. – Cambridge: MIT Press, 2013. – 520 p.
7. Kibert C.J. Sustainable Construction: Green Building Design and Delivery. – 4th ed. – Hoboken: Wiley, 2016. – 624 p.
8. Ali M.M., Moon K.S. Structural Developments in Tall Buildings: Current Trends and Future Prospects // Architectural Science Review. – 2007. – Vol. 50, No. 3. – P. 205–223.
9. Wang L., Chen T. Artificial Intelligence in Smart Buildings: A Comprehensive Review // Automation in Construction. – 2021. – Vol. 125. – P. 103-118.
10. Lawson M., Ogden R., Goodier C. Design in Modular Construction. – London: CRC Press, 2014. – 288 p.
11. Graham S., Marvin S. Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition. – London: Routledge, 2001. – 480 p.
12. Sassen S. The Global City: New York, London, Tokyo. – Princeton: Princeton University Press, 2001. – 480 p.
13. Gissen D. Big and Green: Toward Sustainable Architecture in the 21st Century. – New York: Princeton Architectural Press, 2002. – 192 p.
14. Yorqulov F. Aqlli, ko‘p funksional binolar arxitektura konsepsiyasida Smart-city va smart-building texnologiyalarining Integratsiyasi. Ilm fan xabarnomasi. 2026
15. Yorqulov F. Integration of smart-city and smart-building technologies in the Architectural concept of intelligent multifunctional buildings. International multidisciplinary online journal. 2026